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ELECTROLYSIS¹

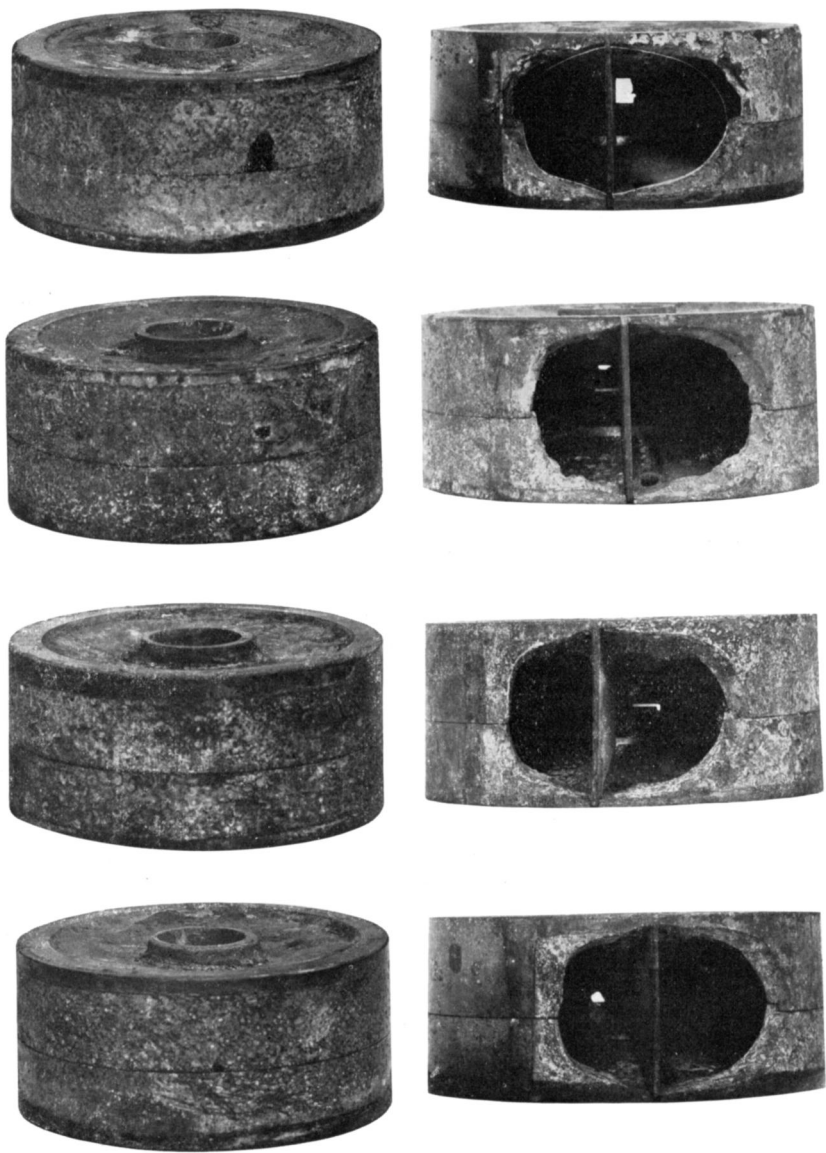
FRED B. NELSON: Tests and examinations have been recently made by the New York department of water supply on fifty meters which had been in continuous service for different periods of time, including five groups of ten each installed at five year intervals from 1895 to 1915. It may be of interest as having a possible bearing on the subject of electrolysis that on the disc chambers of those installed in 1900 a decomposition or pitting of the bronze chambers was found which was not present in any marked degree on those installed in 1895 nor on subsequent installations. The appearance of the decomposed metal suggested electrolytic action and analyses were made by the Central Testing Laboratory of the bronzes of the disc chambers affected and of one disc chamber not affected, from which the conclusion was drawn that the decomposition was due to a solution of the metal, the solution depending upon a number of factors, among which was the difference in composition or mechanical treatment and consequent differences of potential between adjacent portions of the meter.

The analyses showed quite marked differences of composition of the bronze even between the two halves of the individual disc chambers, these differences being least in the analyses of the unaffected chamber. The analyses also seemed to show that the bronzes higher in zinc and lead were the most susceptible to the corrosion. Analyses of the water being used through these meters showed no chemical differences that would account for the difference in corrosion.

This case of corrosion of bronzes is not cited as an instance of the usual action of electrolysis, as no indication or instance could be found to indicate that any stray electric currents existed or were leaving the bronze at the affected portions. It does, however, seem to illustrate a somewhat similar decomposition of the metal that may be caused by local galvanic action due to differences in composition or treatment of the adjacent bronzes used.

The appearance of the corroded disc chambers is shown in the accompanying illustration.

¹ A discussion of an informal address by Prof. Albert F. Ganz before the New York Section on December 20, 1916.



APPEARANCE OF CORRODED DISC CHAMBERS

H. B. MACHEN: A rather interesting case of what we believe was electrolysis recently appeared in the borough of The Bronx, New York City, where as you know the entire trolley system is of the single wire overhead type.

A leak was reported as at 132d Street near Lincoln Avenue. The department forces made the necessary excavations exposing the pipe and found that for a small portion of the pipe the iron had practically disappeared, leaving the carbon, the specific gravity of a section broken out about 6 inches square being about 2.

An examination was then made to determine if possible the cause of the local trouble and if possible prevent its recurrence. The pipe runs for about 800 feet through made ground which at the point where the pipe was exposed consisted of a fair grade of earthfill. The trench was dry, although but 600 feet from tidewater. The nearest elevated railroad and trolley lines were about 400 feet in a straight line. There was no difference of potential between the pipe and elevated railway except when a train was passing, and but very slight at that time. No differences could be detected at any time between the pipe and the trolley road. Examination of the pipe, which had been tested to 150 pounds at the foundry where manufactured and had been in service for a number of years at approximately 35 pounds pressure, showed that the trouble was confined to one length only. The total area affected was about 4 square feet toward one end of the length and indicated that the iron had been largely extracted, leaving carbon so soft that it marked paper easily. The pipe coating was in good condition in many places, having still the original gloss evident. To date it has not been possible to locate any source of current, either to or from the pipe, and still every fact available after the break disclosed the weak spot points to electrolysis as its cause.

As an illustration, the reverse of the case mentioned above and located in the same borough might be cited; the 36-inch main on Jerome Avenue where the pipe parallels a trolley line for over 5 miles. During a repair being made at night, just as the sleeve was being slipped over the end of the pipe, several sparks jumped the gap which appeared from the bank to be about 1 inch and which surely was over $\frac{1}{2}$ inch. This certainly indicated that the pipe was carrying current, and still we have had no trouble appear from electrolysis, which can have been going on for twenty years.

D. F. ATKINS: The department of water supply, gas and electricity of New York has received applications from electric railway companies for permission to bond their tracks to the water mains. This permission has been refused in every case, for there has been no proof offered that the city would gain anything by permitting such bonding, whereas the railway companies would thereby be relieved in a measure of the necessity of bonding their tracks so as to form a proper return circuit, which they should provide.

HARRY V. ALLEN: A water consumer in an outlying section of Brooklyn was required to pay a bill for water which was in part wasted on account of a leak in the pipe between the meter and the fixtures. The pipe had been corroded by electrolysis and he wished to recover for the loss he had sustained. A joint investigation made by the department of water supply, gas and electricity and by the public service commission indicated that the tracks in the neighborhood were poorly bonded and there was a flow of current from them to the sub-station through the intervening marshy ground. The tests indicated that the water mains were carrying heavy currents for some distance toward the sub-station, and that the currents then left the water mains and returned through the damp soil. The conditions were such that one of the lead service pipes transmitted currents which would theoretically eat away about 15 pounds of metal annually. The joint tests were suspended owing to representations made before the commission questioning its jurisdiction to order circuit changes on the part of the company, which were necessary to a conclusive test.

NICHOLAS S. HILL, JR.: In 1895 we were installing in Baltimore near an electric railway power station an underground conduit system for telephone and telegraph cables. We laid lead-covered cables with their ends tied together but in three weeks time the lead covering was entirely gone. The cables were laid in a weak solution of sewage and everything was favorable for corrosion. The action was so rapid that it was necessary to make an electrical survey at once. We did not know then as much about electrolysis as we do now, and the first thing we thought of doing was to connect the cables with the busbar of the power station. When this was done we found that we were returning about 1800 out of the 2800 amperes supplied by the station.

There is but one solution of the problem of electrolysis. That is insulation of the rails so far as possible and increase in the conductivity of the track circuit back to the station within economical limits. It is unwise to attempt to force methods upon the railways which are so expensive that they are prohibitive. I have felt, and this opinion is substantiated by the decisions in the suits brought at Peoria, Indianapolis, Dayton and elsewhere, that we gain nothing by bringing suits which attempt to force a particular kind of construction on the railways, because when the water department or water company appeals to the courts on such a basis, the construction demanded is such that it is easy to prove to the courts that such a requirement amounts to confiscation and the courts are loath to do anything which has even the appearance of confiscation.

The attitude of this association in the matter of electrolysis should be one of coöperation and arbitration rather than one of coercion. If damage is done, we have the same methods of recovery that any person has by bringing suit to force the offender to pay for the damage he actually does, but I do not believe we can profitably use the courts in any other way than the recovery for damage sustained. We are working in the streets in conjunction with other public utilities and we all have equal rights in them. What we should do is to coöperate with engineers who are better equipped by training to attack the problem of electrolysis and to formulate with them remedial measures and standards of construction which will reduce this trouble to a minimum.

D. W. FRENCH: I do not think the experience the Hackensack water company has had from electrolysis is unlike that of any other water company. We have usually found that such trouble as we had was due to poor rail bonding, and when voltmeter readings exposed what was going on and the matter called to the attention of the railway officials, they were generally remedied. A number of lead service mains have been completely ruined by stray currents and these services have been replaced by the railway company at their expense.

HERMANN ROSENTERETER: We have found an unusual instance of the straying of return currents in New Jersey. There is an electric railway running southwesterly from Paterson and paralleled by a 42-inch main supplying Jersey City. A 42- and a 48-inch main

supplying Newark intersects the railway and runs directly away from the station supplying current for the cars. A leak in the Newark mains was reported in a swamp about $3\frac{1}{2}$ miles from the railway crossing. Investigation showed about 20 amperes flowing in the mains at that place and several miles farther from the power station we found a current of 2 amperes. In order to be sure that the current came from the railway, measurements were made one night before and after the road was shut down. When the car service stopped the current flowing out over the mains stopped and a small current flowing toward the Paterson power station was observed. In other words, current from the station strayed 11 miles away from the railway on which it was supposed to remain.

ALEXANDER POTTER: At San Antonio, Texas, we found the service pipes pitted with what appeared to be electrolytic corrosion. This appeared in all parts of the city and an experiment in the way of protection is now being made. This is to cover the services with tile pipe, which has not been in use long enough to prove its usefulness.

F. T. KEMBLE: Our troubles with electrolysis in New Rochelle are pretty much the same as those of everybody else, though the points at which it occurs are rather localized. But there is one condition that probably differs from other plants that may be of interest to you. Along the Long Island Sound shore section much of the trolley return current is carried over the tracks of the New Haven Railroad, who have their tracks bonded directly to the busbar in the power house of the trolley company. Professor Ganz has made a study of our section and is entirely familiar with this condition. As showing one of the channels through which the current has traveled, we have on two occasions found a 1-inch piston meter, which was set on the railroad company's own connection near its tank house, have its piston so warped that the meter ceased to register. After the second occurrence, which was after an interval of about six weeks, we placed the meter in a vault close to our main, a distance of less than 200 feet from the original location, and since then we have had no further trouble with it.

ALLEN HAZEN: It is well to bear in mind that punk metal is not necessarily due to electrolysis. Iron pipe has been found in a punky condition miles away from any electric railway and where

there was no possibility of its being due to electrolysis. In such cases it is doubtless the result of the chemical action of the soil. The alkali in certain western soils seems to have a powerful action of this kind. Several years ago, in building a steel water pipe, at each crossing of, an electric railway, the pipe was covered with building paper in successive layers, each of which was heavily coated with tar. This treatment was inexpensive and seems to have been in line with the treatment suggested by Professor Ganz.

PROF. ALBERT F. GANZ: It is not generally possible to satisfactorily answer questions in regard to electrolysis unless complete information stating all of the conditions can be given. It is generally difficult to obtain such complete information from inquiries made in connection with discussions before meetings like this.

I am glad to hear that the department of water supply, gas and electricity of New York City has refused to permit the electric railway companies to bond their water mains to the railway tracks. Such permission should not be granted because the bonding of water pipes to the tracks makes the water piping system part of the railway return circuit, and almost always makes the piping system carry very large currents, and these become an increasing source of serious danger. Mr. Nicholas S. Hill has well illustrated by his experience in Baltimore that it is of great advantage to railway companies to connect underground structures to their railway return circuit, as they thereby obtain the use of these underground structures for the return of current. He has also shown that these structures are made to carry very large currents by such connections.

In regard to the attempt in San Antonio to stop electrolysis by encasing the water services in tile pipes, I beg to say that this arrangement can only succeed if the joints in the tile pipe and the connection to the water service are made waterproof, so that the space between the service pipe and the tile pipe does not fill with water. If this space does fill with water, then current may continue to flow from the service pipe to the water and produce corresponding corrosion of the service pipe by electrolysis. I would suggest as an improvement that the space be filled with a compound like pitch.

The heating of the 2-inch water meter by current from the New York, New Haven and Hartford Railroad in New Rochelle is very interesting, and I am sorry that I have not more details in regard

to this very important observation. Mr. Hazen's remarks emphasize the fact that it is not possible to tell from the appearance of a corroded pipe alone whether it has suffered from electrolysis or from purely chemical action. To determine this, requires electrical measurements to see whether current is leaving the pipe which could produce electrolysis.

In regard to lead service pipes which are reported to be destroyed by electrolysis from current reaching the water service pipe from the gas main by way of the house service connections, I would suggest that if this is the path of the current which damages the water service pipe, the trouble can be remedied by inserting an insulating joint in the water service directly inside of the cellar wall, thereby preventing the flow of the damaging current out on the water service pipe. If, on the other hand, the current flows from the water main to the water service pipe, then an insulating joint would have to be inserted in the water service pipe close to the main. A safe precaution would be to insert an insulating joint in the water service pipe both close to the main and directly inside of the building.

In regard to the question of grounding transformer secondaries to water pipes, I would say that there is absolutely no danger in permitting such connections to be made. Transformers operate with alternating current, and the object of grounding the secondaries of transformers is to serve as a safety measure to prevent the possibility of persons obtaining a high voltage shock. Under normal operating conditions there is no flow of current to the water pipe from such transformer connections, and in my opinion such connections can be safely permitted.